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ITCS332: Concepts of Programming Languages FIRST TEST

Date: APR 09, 2006

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QUESTION ONE:

[08 pts]

- a) The following Prolog predicate is supposed to calculate  $Z = X^Y$ , which means Z is equal to X to the power Y. Where, Y must be an integer greater than 0 and  $X \neq 1 = X$ . But the code wouldn't work since it has errors. Underline and correct the errors. Rewrite the correct code. The following queries may help you.

?- power(3,4,U).

U = 81

Yes

?- power(2.5,3,M).

M = 15.625

Yes

?- power(2,2.5,N).

No

power(X, 1, X)

power(X, Y, Z) :- Y > 1, Y1 is Y - 1, power(X, Y1, Z1), Z = X \* Z1.

$$3^4 = 3 \times 3 \times 3 \times 3 \\ = (3 \times 3) \times 3^2 \\ = (3 \times 3) \times 3 \times 3 \\ = 3 \times 3 \times 3 \times 3$$

Power(X, Y, Z) :-

Y > 0, Y1 is Y - 1,

Power(X, 1, X).

Power(X, Y, Z) :- Y > 0, Y1 is Y - 1, Power(X, Y1, Z1), Z = X \* Z1.

- b) Assume that you are given the following predicate "member" that produces "yes" if a given value is a member in a given list. Define a Prolog predicate intersect(X, Y) that takes 2 lists X and Y and produces "yes" if the lists intersect. Two lists intersect if they have a common element. The following 2 queries may help you.

?- intersect([a, c, e, g], [b, c, d]).

Yes

?- intersect([a, c, e, g], [b, d, f]).

No

member(H, [H | \_]).

member(H, [\_ | T1]) :- member(H, T1).

intersect([\_], [\_]).

intersect(X, X).

intersect(X, Y) :- member(X, Y),

member(X, Y).

~~intersect([\_], [\_]).~~

~~intersect(X, X).~~

~~intersect(X, Y) :- member(X, Y), member(X, Y).~~

- a) Give the BNF grammar rules that define a hexadecimal constant. A hexadecimal constant is a sequence of one or more hexadecimal digits followed by H. Hexadecimal digits are:  $T = \{0, 1, \dots, 9, A, B, \dots, F\}$ .  $N = \{\langle \text{hexconst} \rangle, \langle \text{sequence} \rangle, \langle \text{hexdigit} \rangle\}$ .  $S = \langle \text{hexconst} \rangle$ .

~~$\langle \text{hexconst} \rangle \rightarrow \langle \text{hexdigit} \rangle \langle \text{sequence} \rangle \langle \text{hexdigit} \rangle \langle \text{hexconst} \rangle$~~   
 ~~$\langle \text{sequence} \rangle \rightarrow H$~~   
 ~~$\langle \text{hexdigit} \rangle \rightarrow 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F$~~

$\langle \text{hexconst} \rangle \rightarrow \langle \text{sequence} \rangle$   
 $\langle \text{sequence} \rangle \rightarrow \langle \text{hexdigit} \rangle H | \langle \text{hexdigit} \rangle \langle \text{sequence} \rangle$   
 $\langle \text{hexdigit} \rangle \rightarrow 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F$

- b) Convert the following BNF rules into equivalent ONE EBNF rule:

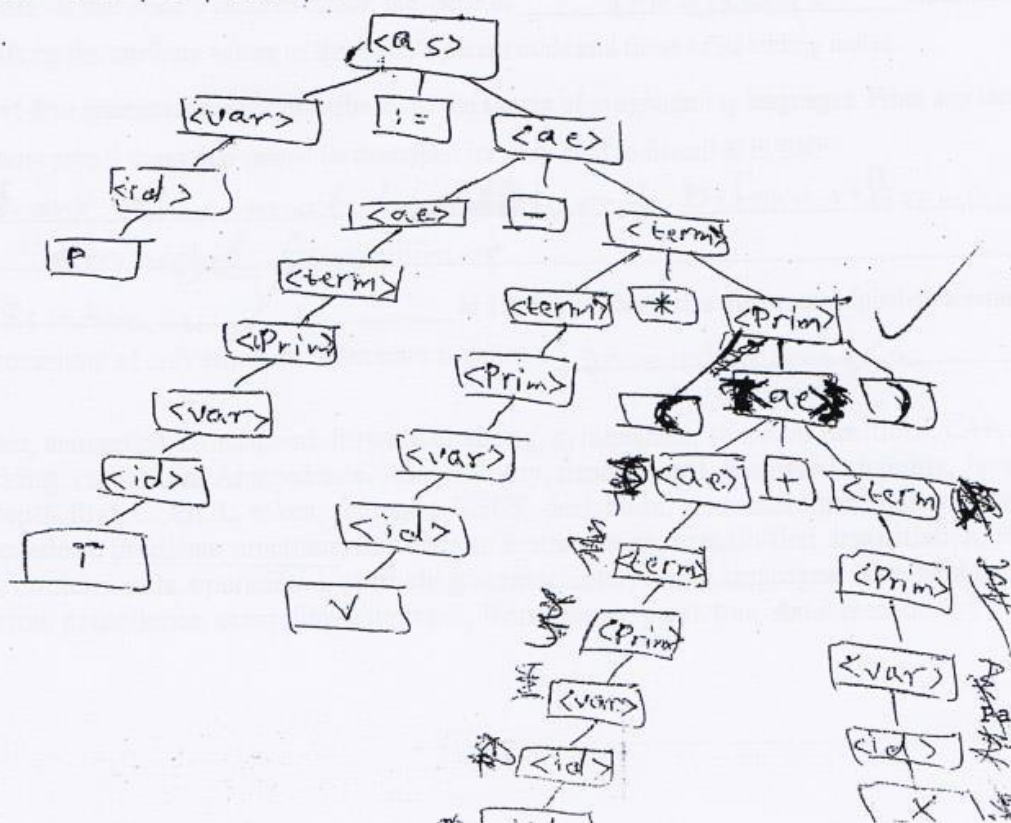
$\langle S \rangle \rightarrow \langle S \rangle ^ \wedge \langle G \rangle | \langle S \rangle ^ * \langle G \rangle | \langle S \rangle ^ / \langle G \rangle | \langle G \rangle$   
 $\langle S \rangle \rightarrow \langle G \rangle \{ \wedge | * | / \} \langle G \rangle$

- c) Convert the following EBNF rules into equivalent BNF rule(s):

$\langle \text{var} \rangle \rightarrow \langle \text{id} \rangle | \langle \text{id} \rangle [ ( \langle \text{sub\_list} \rangle ) ]$   
 $\langle \text{var} \rangle \rightarrow \langle \text{id} \rangle$   
 $| \langle \text{id} \rangle ( \langle \text{sub\_list} \rangle )$

- d) Consider the following grammar and construct the parse tree for the following assignment statement:  $P := T - V * (W + X)$

$\langle \text{as} \rangle \rightarrow \langle \text{var} \rangle := \langle \text{ae} \rangle$   
 $\langle \text{ae} \rangle \rightarrow \langle \text{term} \rangle | \langle \text{ae} \rangle + \langle \text{term} \rangle | \langle \text{ae} \rangle - \langle \text{term} \rangle$   
 $\langle \text{term} \rangle \rightarrow \langle \text{prim} \rangle | \langle \text{term} \rangle * \langle \text{prim} \rangle | \langle \text{term} \rangle / \langle \text{prim} \rangle$   
 $\langle \text{prim} \rangle \rightarrow \langle \text{var} \rangle | \langle \text{num} \rangle | ( \langle \text{ae} \rangle )$   
 $\langle \text{var} \rangle \rightarrow \langle \text{id} \rangle | \langle \text{id} \rangle [ ( \langle \text{sub\_list} \rangle ) ]$   
 $\langle \text{id} \rangle \rightarrow A | B | \dots | Z$





QUESTION THREE: Fill in blanks Questions

[12 pts]

- 1) The 4 language evaluation criteria are: readability, writeability, reliability, and cost.
- 2) The Web is supported by a collection of languages: general-purpose (e.g., Java), markup (XHTML) and scripting (PHP).
- 3) Language design is influenced by: computer design and —.
- 4) The third and fourth phases of a compilation process are: semantic analysis and code generation.
- 5) An example of programming languages that fits business applications is COBOL and an example of programming languages that fits scientific applications is Fortran.
- 6) Programming languages based on variables, assignment statement, and iteration belong to imperative language category; languages based on data abstraction, inheritance, and polymorphism belong to functional category.
- 7) Prolog has 3 kinds of statements: fact statements, rule statement and functors.
- 8) The process of finding useful values for variables in propositions that allows matching process to succeed is called unification. The process of repeated application of grammar rules, starting with the start symbol and ending with a sentence is called derivation.
- 9) The number of lexemes in a sentence "for (i=0; i<size; i++)" is 12; the number of different tokens in the same sentence is 8.
- 10) The value of synthesized attribute depends only on the values of the attributes on that node's children nodes; the value of inherited attribute depends on the attribute values of that node's parent node and those of its sibling nodes.
- 11) Context-free grammars cannot describe all of the syntax of programming languages. From any language you know give 2 cases that cannot be described (or very hard to describe) in BNF:  
any value must be declared before referenced or semantic functions.
- 12) A sentence is a string of characters over some alphabet; a sentential form consisting of only terminals or lexemes is called a generated sentence.

{ axiomatic, semantics, consequent, forward chaining, synthesized, semantic functions, C++, Perl, type checking, resolution, Antecedence, Associativity, denotational, backward chaining, Java, BNF, lexeme, depth-first, COBOL, token, sentence, EBNF, derivation, sentential form, syntax, inherited, LISP, antecedent, predicate functions, unification, consequence, breadth-first, instantiation, Prolog, terminals, nonterminals, operational, attribute grammar, interpreting languages, statement decode left recursion, precedence, compiling languages, Horn clause, parse tree, static semantics }



QUESTION FOUR: For each of the following questions, choose the BEST answer. [12 pts]

- 1) Perl is a language that is \_\_\_\_\_  
 a) interpreted                      b) compiled                      ☒ c) both a and b                      d) none
- 2) ?- Y is X+2, X=1.  
 a) Y = 1+2  
    X = 1                      ☒ b) Y = 3  
    X = 1                      ☒ c) error message                      d) Y = X+2  
    X = 1
- 3) We use EBNF to describe the \_\_\_\_\_ of programming languages.  
☒ a) syntax                      b) semantics                      c) both syntax and semantics                      d) none
- 4) With an unambiguous grammar, how many parse trees are there for any given string that is in the language?  
 a) zero                      ☒ b) exactly one                      c) one or more                      d) infinitely many
- 5) The order of operator evaluation in the expression: 5-6\*4 is defined by:  
☒ a) Precedence rules                      b) Associativity rules                      c) Orthogonality                      d) None
- 6) The applications that require producing reports and processing huge amounts of decimal numbers belong to \_\_\_\_\_ domain.  
 a) Scientific                      ☒ b) Business                      c) Web                      d) AI
- 7) A language feature: "Short and convenient ways to express powerful operations" is called:  
☒ a) Expressivity                      b) Multiplicity                      c) Orthogonality                      d) None
- 8) The type of semantics in which each statement of a program is both preceded and followed by "predicates", is called:  
 a) Operational                      b) denotational                      c) static semantics                      ☒ d) axiomatic
- 9) The process of translating a source program into a set of tokens is called:  
 a) Parsing                      ☒ b) Scanning                      c) Symantics analysis                      d) Optimiztion
- 10) ?- append(X,Y,[1,2,3]).  
 a) X = []                      b) X = [1]                      c) X = [1, 2]                      d) ALL  
    Y = [1, 2, 3]                      Y = [2, 3]                      Y = [3]
- 11) ?- [1,2|X] = [1,2,3,4,5].  
 a) error                      b) X = [3,4]                      ☒ c) X = [3,4,5]                      d) none
- 12) ?- Y=X+2, X=1.  
 a) Y = 1+2  
    X = 1                      b) Y = 3  
    X = 1                      c) error message                      d) Y = X+2  
    X = 1

Question #	1	2	3	4	5	6	7	8	9	10	11	12
Answer	<del>a</del>	<del>a</del>	a	b	a	b	a	d	<del>a</del>	<del>a</del>	c	<del>a</del>